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THE NEED FOR THE INTERNET OF LIFE (IOL) - A CLOUD ENABLED ARCHITECTURE FOR HEALTHCARE STAKEHOLDERS

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ABSTRACT

Richardson (2006) defined ED crowding as patient occupancy at, or greater than, the 75th percentile for a given time period.[1]This definition has been used by dividing the day into six 4-hour intervals. For each time interval, the percent of total capacity for the ED was calculated. If the ED was over 75% occupied, it was considered crowded for the corresponding time interval.

Other researchers have based their conceptual definition on the Crowding Resources Task Force of 2002 which states that crowding is a "situation in which the identified need for emergency services outstrips available resources in the ED".[2]According to the Task Force, this situation occurs when the number of ED patients outnumbers the staffed ED treatment beds and wait times exceed a reasonable period.[3]

Key words: Internet of Life, Internet In Healthcare, Cloud Enabled Healthcare.

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COST OF ED CROWDING

In addition to the patient satisfaction and the physiological impact on patients, ED crowding has a financial impact on hospitals and payers. Much of the research regarding the financial cost of ED crowding has been associated with the hospitals where crowding occurs. Such costs include opportunity losses from revenue from ambulance diversion, patients leaving without being seen, loss of returning patients due to decreased satisfaction scores, and incentives to recruit and retain staff exposed to the stressor of ED crowding.

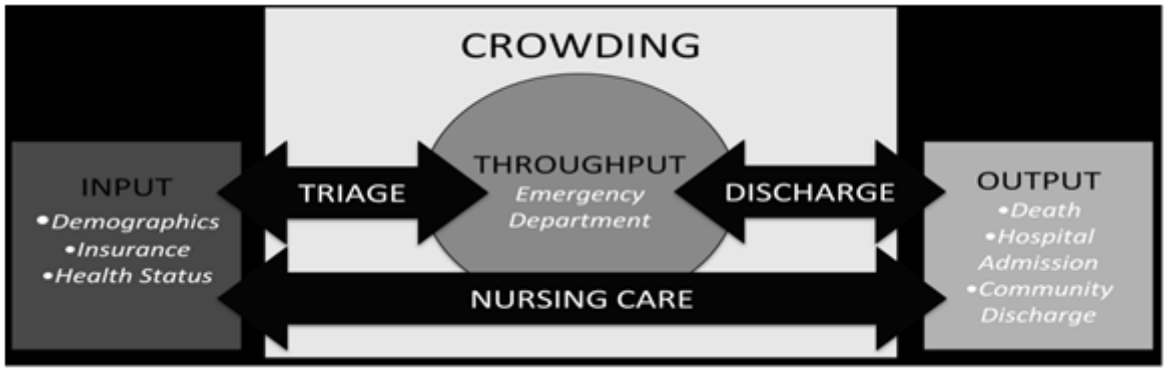
Two articles were located that calculated the financial effect of ED crowding on the hospital. One study estimated that the hospital lost $204 in potential revenue per patient with an extended ED boarding time and sustained an annual opportunity cost in lost hospital revenue for chest pain patients of $168,300.[4]Another study found that patients who boarded in the ED longer than a day stayed in the hospital longer which increased costs by an estimated $6.8 million during a 3 years period.[5]

Ambulance diversion is another source of potential opportunity of cost losses. One study found that during 1 in 8 patient transports, the ambulance could not unload the patient promptly at the ED, putting it out of service for 15 minutes or more.[6] Another study reported that delays, due to ambulance diversion and the lack of available inpatient beds, required more staff and equipment to be used at a cost of $1 million per year in a single community.[7]

TOOL FOR ED CROWDING

Asplin's Model of ED Crowding was used to understand various factors leading to crowding in the emergency department. Table 4 shows these factors, the most common reason being lag in time between vital sign recording.

Table 4 Asplin's Model of Emergency Department Crowding



Input	Triage	Throughput	Nursing Care	Crowding
Number of Prescription Medications	Triage Category	Length of time between Vital Sign Recording	Number of Routes of Medications Administered in ED	EDWIN
Number of OTC Medications		Length of Stay		
Family Presence				
Comorbidities				
Insurance Status				
Marital Status				
Ethnicity				
Age				
Gender				
Arrival in Private Car				

To clarify the relationship between the variables that were included in the model and the broader concepts within the theoretical model, a substruction of the model was created. The variables that were used for each concept are located under the concept heading.One of the most common tasks of an emergency nurse is to assess the vital signs of their patients. Vital signs provide rich sources of information on a patient's condition and are commonly obtained in triage, routine nursing assessments, throughout the continued monitoring of patients and at the time of discharge. Vital signs, or signs of life, were so named because they provide interpretable information as to the vital state of the patient. Vital signs are easily obtained by nursing staff and obtaining them can be accomplished regardless of the patient‟s level of consciousness. The number of components that make up the collective term of vital signs varies. Four measures are typically included in vital sign reporting: (a) temperature, (b) heart rate or pulse, (c) respiratory rate, and (d) blood pressure.

Temperature. Body temperature (T), is a measure of the body‟s ability to generate and get rid of heat. There are three states a person can be in related to body temperature: hypothermic, normothermic, and hyperthermic. Hypothermia is defined as a body temperature below 35°C (95°F). Hypothermia occurs when more heat is lost than the body can generate. This state usually occurs due to extended exposure to the cold or inability to keep up a metabolic rate. Hypothermia can lead to lethargy, cardiac arrest, shock, coma and. Hyperthermia, also called pyrexia or fever, is considered when the body temperature of an adult reaches or exceeds 100.5°F (>38°C). The potential causes of hyperthermia are numerous and include infections (viral or bacterial), drugs or toxins, severe trauma, autoimmune diseases, some cancers and extended exposure to an external heat source.

The definition of normal body temperature varies. It has been identified as greater than hypothermic and less than hyperthermic and from 35°C (95°F) to 38°C (100.4°F). the average normal body temperature is 37 degrees Celsius (98.6 degrees Fahrenheit) but can vary by 0.6°C (1°F). Normal body temperature varies due to age, menstruation and time of day. However, temperature varies less in adults than children. Normal body temperature taken orally is 98.6°F (37°C), with a range of 97.8–99.1°F (36.5–37.2°C).

Heart rate. Heart rate (HR), or pulse, is an important vital sign that is a measurement of the number of contractions of the ventricles of the heart per minute. Heart rate is different than heart rhythm in that in order to accurately determine a heart rhythm a cardiac monitor is required while HR can be determined by auscultation through a stethoscope or by manual palpation by applying pressure over an artery. Heart rate can be classified as normal, slow (bradycardia), or fast (tachycardia).

Bradycardia is defined as a heart rate below 60 beats per minute (bpm) in adults. Bradycardia may be normal in athletes or patients on medications such as beta-blockers, but may be an indication of an acute MI, Acute Coronary Syndrome or an electrical conduction problem within the heart, any of which may lead to death. Because patients suffering from bradycardia may not be symptomatic, HR is an important measure in detecting many life threatening conditions. Tachycardia is defined as a heart rate greater than 100 bpm. Some common causes of tachycardia are fever, hypovolemia, anxiety, hyperthyroidism and normal exercise. Uncontrolled tachycardia can cause inadequate tissue perfusion due to insufficient ventricular filling time leading to cardiac arrest or death.

A heart rate is considered normal when it ranges between 60 and 100 bpm but may vary based on gender, age, fitness level, daily medications and genetics. Because both bradycardia and tachycardia can result in adverse outcomes, it is apparent why heart rate is such an important vital sign. *Respiratory rate.* Respiratory rate (RR) is the number of breaths inhaled per minute and is usually measured by observing the number of times a patient‟s chest rises in a minute. Respiratory rate may be the most controversial of all the vital signs. Respiratory rates are often assessed inaccurately. However, studies have demonstrated that the manual measurement of respiratory rate appears to be reliable. Respiratory rates may be classified as normal (RR >12 and <20), tachypnea (RR > 20 breaths/minute), bradypnea (RR < 12 breaths/minute) or apnea (RR=0). Tachypnea is associated with cardiac arrhythmias, amphetamine abuse, an acidotic state, traumatic brain injury, anxiety, asthma and other causes of respiratory inflammation while bradypnea is associated with shock, head injury/skull fracture, alkalosis, and hypothermia.

Blood pressure. Blood pressure (BP), measured in millimeters of mercury (mmHg), is the pressure exerted on the walls of blood vessels by circulating. The two components that determine BP are the systolic and diastolic measures. Systolic blood pressure (SBP) is the amount of pressure exerted on the blood vessels during the contraction of the ventricles of the heart. Diastolic blood pressure (DBP) is the amount of pressure exerted on blood vessels during the period of time when the ventricles are at rest. Adult BP can be described in one of four categories: hypotensive (SBP <90 or DBP <60), normotensive (SBP between 90-119 and DBP between 60-79), prehypertensive (SBP between 120-139 or DBP between 80-89), or hypertensive (SBP ≥140 or DBP≥90). Blood pressures fluctuate normally throughout the day. However pressures outside of the normotensive range may be indicative of underlying health conditions. Hypertension may be a chronic condition or situational due to anxiety or fear. Due to the risks associated with hypertension, patients may present to the ED suffering from MI, heart failure, cerebrovascular accidents or arterial aneurysms. Symptoms associated with hypertension are headache, tinnitus, dizziness, confusion, fatigue, nose bleeds or heart palpitations. Hypotension may indicate that a patient is (a) in a state of hypovolemia, (b) having side effects from a medication (e.g. antidepressants), (c) abnormal stimulation of the vagus nerve or (d) shock. Symptoms associated with hypotension are dizziness, angina, or fainting.

Peripheral oxygenation. Peripheral oxygenation (SpO2) or hemoglobin saturation is routinely measured by placing a pulse oximeter on the patient‟s finger. This vital sign is defined as the amount of oxygen being carried in the red blood cells. Normal SpO2 level are

greater than 92% saturation. A SpO2 level less than 90% may be indicative of chronic obstructive pulmonary disease, sleep apnea, asthma, pneumonia, respiratory insufficiency and anemia. Low SpO2 levels can cause cyanosis, anxiety, decreased level of consciousness, confusion and death.

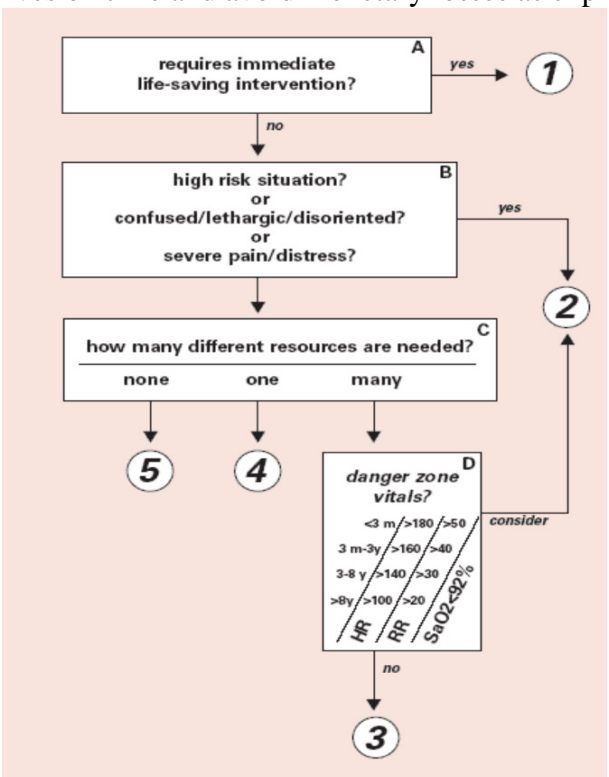
Composite vital signs. Although each vital sign is important in assessing a patient‟s condition, a composite vital sign measure may be a better indicator of the true condition of a patient‟s health. Composite vital signs may provide a more holistic description of a patient at risk or that is experiencing important impaired health or catastrophic derangement.

Monitoring Vital Signs

Research demonstrates that crowding increases stress in both patients and staff in the ED. During periods of stress, the sympathetic nervous system is activated which prepares the body for “fight or flight” which causes changes in several components of vital signs (e.g. accelerated heart and respiratory rate and elevated blood pressure). In addition, stress hormones can increase pain sensation. Contextual factors can suggest a need for frequent monitoring despite normal vital signs or infrequent monitoring despite abnormal vital sign values.

However, it is believed that these delays can be reduced. Adverse outcomes caused by delays can be minimized by decreasing the time to measure vitals.

Vital signs have been used to determine early warning signs of patient deterioration. For example, vital signs have been shown to be reliable predictors of the need for life-saving interventions in trauma patients same is demonstrated in figure 11, along with explanation of levels of Emergency and the triaging system. With the help of IoL not only the time spent in measuring vitals will be reduced but also will help hospitals in avoiding ED crowding, saving lives on time and avoid monetary losses as explained under Cost of ED Crowding.



Level I	Resuscitation	see patient immediately
Level II	Emergency	within 15 minutes
Level III	Urgency	within 30 minutes
Level IV	Less Urgency	within 60 minutes
Level V	Non Urgency	within 120 minutes

Figure 11 Emergency Triaging

Harshal Lowalekar and N. Ravichandran in their study conducted at Rajas Eye Hospital and Retina Research Centre found that "The efficiency of the current operations at the hospital could be improved by implementing an automation system that will help in automating various processes like patient scheduling, documentation, etc. (which are done manually under the current system) at the hospital."[8] IoL can be one such solution which will help the hospitals in appointment, billing, pharmacy, pathology, radiology etc and majority of this task will be automated.

It goes without saying that the efficiency would increase manifolds if the Medical History is already available to the doctor. The doctor can give more time to the current diagnosis rather than knowing the past medical history and in some cases family medical history. The outpatient department is the point of contact between the health care facility and the community. The problems of OPDs of developing countries are long waiting times, long queues, inefficient staffs, absence of staffs etc. The problem is graver when the OPD runs in the rural area, because of huge patient load. No comparable time motion studies have been carried out in any other OPD of rural hospital.

Hence after keeping in view all the above facts and figures we can finally conclude that not only valuable time of Stakeholders would be saved but there will be an immense increase in the efficiency of the Hospital Human Resources. With this the patient will have to spend less time doing the repetitive work of explain past medical conditions, in which he / she can miss out on minute details that may affect the current well being and ailment of the patient. These records can be stored on the cloud and can be retrieved on request.

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